Flood Forecasting in Bangladesh

Types of Flood forecasting

Flood forecasting can be divided into two categories:

- Flood forecasting in the rivers caused by upstream rise of river stage as well as rainfall in the basin.
- Overland flow from upstream
- Flash flood forecasting in small basins generally induced by heavy localized rainfall and characterized by sharp rise and fall.

The present operational flood forecasting in Bangladesh is said to be satisfactory for situations trapped by rivers for a limited lead time and are not so for over land access and flash flood. In all the cases, mathematical hydraulic models are used with updating procedures for the forecasting. A calibrated and verified model with 2400 computational points are in use. Observed water level boundary is used in the upstream boundary with estimation of rainfall. The output is presented in a model interfaced GIS format. This facilitates production of flood maps in addition to forecast hydrograph.

Confidence Level of Forecast

Confidence Level of Forecasts has been established on the basis of mean absolute error (as compared to observed levels) at a forecast location and is given below.

Location	**Station/River**	**Mean Absolute Error (in centimeter)**		
		24-hour forecast	*48-hour forecast*	*72-hour forecast*
Near the border	Chilmari on Brahmaputra River/ Chapai-Nawabganj on Mohananda River	12	17	24
Central Region	Dhaka on Buriganga River	5	8	10
Hilly catchment	Kanaighat on Surma River Moulvi Bazar on Manu River	25	42	55
Coastal belt	Chandpur on Meghna River	25	27	30

The over land flow cases are investigated and it will require more information from upstream including operation of structures. The present forecasting can not provide forecast for local rainfall or the effects of local rainfall can be identified separately. Regarding the confidence level of forecasts, additional improvement can be expected at the end of the current development project scheduled for completion in 2004 for the following activities:

- Forecast points near upstream border are influenced by boundary estimates (estimations are subjective and vary depending on the skills of the person who is making the estimate). Use of correlation from upstream might improve forecast near border.
- Forecast points at hilly catchment depend highly on local and upstream rainfalls and, therefore, no improvement is expected in this area.
- Present model does not show good calibration at tidal locations. If the calibration is improved then forecast at tidal belt might be improved.

Weaknesses of present flood forecasting system

Weaknesses of present flood forecasting system in Bangladesh can be seen as follows:

- Present Flood Forecasting model cannot be extended beyond the geographical border of Bangladesh as the limited and discontinuous data available from outside Bangladesh can not support a meaningful model to provide a larger lead time. Some hydrometric data are sent to FFWC when water levels in some upstream rivers cross danger levels (or close to danger levels). But these data are not sufficient to extend the model beyond the country's geographical boundary (and even not sufficient to investigate correlation among gauge stations inside Bangladesh area).
- Therefore present forecast is carried out only up to 72 hours.
- Forecast for 72 hour is good only at central region of the country as stations closer to boundaries are influenced by the subjective boundary estimates.
- Operational flood forecasting is highly dependent upon reliable and timely data. At present data are collected manually from gauges. These data are sometimes erroneous and data with shorter intervals are not available (at present 3-hourly data for non-tidal and 1-hourly for tidal stations).
- No quantitative rainfall forecasts are available in Bangladesh (BMD provides only qualitative rainfall forecast for the next 24 hours) and, therefore, subject estimates are made for rainfall for the next 72 hours.
- Available Digital Elevation Model (DEM) is coarse and not sufficient to produce good inundation maps.
- Flood plain interventions and embankment breach information are very much qualitative.

Generation of Downstream Boundary

The FFWC model has 6 tidal downstream boundaries and these are:

- Daulatkhan at Lower_Meghna River
- Dasmunia at Tentulia River
- Patherghata at Buriswar River
- Patherghata and Bishkhali River
- Rayenda at Madhumati River
- Mongla at Rupsa River

At present, downstream water levels at all tidal boundaries are being generated from tidal constituents and observed water levels of last 7 days. If no data is available then water levels are generated from the tidal constituents only. A program developed using Microsoft Excel Macro is

being currently used for this purpose. There is no further program to improve tidal boundary estimation.

Improvement in Flood Map

Under the current ongoing project, the following programs have been planned to improve the quality of flood mapping:

- Cross-sections used in the model are geo-referenced.
- The river network is properly re-aligned so that it follows the natural river/channels.
- Rectification of the currently available 900 meter DEM.
- Attempt to use DEM from external sources (USGS DEM which is free of cost and has a resolution of 90 meter)

Rainfall Estimation

In each region of the country (namely, Northwest, North central, Northeast, Southeast, South central and southwest), FFWC model are sub-divided into small catchments. For the hindcast period, observed rainfall data are fed into the model from the gauge stations. For the forecast period, rainfall estimates are made at 9 regional levels and these are:

NW North Region
NW South Region
NC North Region
NC South Region
NE North Region
NE South Region
SW Region
SC Region
SE Region

For the next 72 hours in the forecast period, all sub-catchments of FFWC model use rainfall estimates from these 9 regional rainfall estimates. The current practice of rainfall estimate is as follows:

1. Average rainfall for the last 3-day (up to the date of forecast) is calculated at 9 regional-levels.
2. Satellite images received through FFWC satellite link and BMD Intranet are gathered.
3. Rainfall forecast from Bangladesh Meteorological Department (BMD) is collected.
4. Past Rainfall situation (qualitative) from the BMD radar (through Intranet) is examined.
5. Rainfall forecast near bordering catchments inside India is collected from the website of Indian Meteorological Department.
6. Analyzing the above-mentioned data, the FFWC forecaster makes rainfall estimates for all the 9 regions during the next 72 hours.

The contributions to errors in rainfall estimates are:

- Model needs quantitative rainfall forecast but BMD provides qualitative rainfall forecast only for the next 24 hours.
- Interpretation of image and other data and later converting this information into quantitative rainfall estimates is often biased and depends significantly on the experiences and skills of the individual who is responsible for the forecast on a particular day.

Findings on the Lead-time vs. upstream data as available from JRC/BMD

Using upstream received through JRC/BMD, some investigations have been made to find lead-time and correlation between relevant stations.

- Noonkhawa (upstream boundary of Brahmaputra River in FFWC model) has a lead-time of approximately 15 hours on Indian station Goalpara (approximately 80 km upstream of Noonkhawa).
- Noonkhawa has a lead-time of approximately 5 hours on Indian station Dhubri (approximately 25 km upstream of Noonkhawa).
- Pankha (upstream boundary of Ganges River) has a lead-time of approximately 3 hours on Farakka (approximately 15 km upstream of Pankha).

Correlations have been established between Noonkhawa and Dhubri, Noonkhawa and Goalpara, Farakka and Pankha. From next year, these correlations will be used for estimating water levels at respective boundaries.

Flood Inundation vs. vulnerability

Each year FFEW provides an annual report to the Government on the performances of the flood forecasting information and present the damages occurred during the year from flood. These are mostly the field information collected from various offices. Attempts are not made to improve the data using FFEW information or remote sensing information. However, during flood, the FFEW data are used by all the infrastructural agencies in safeguarding the property. On an average 22% area is flooded every year but in abnormal cases there are instances of flooding up to 60% areas. Damages to housing, roads, agriculture and lives are severe during such floods. River bank erosion is aggravated in the recession limb of a severe flood uprooting a large section of people making them homeless.

There is a great need for larger lead time – at least for a week.

What we need to do to disseminate Flood Inundation and flood risk by Web Interface

Flood Forecasting & Warning Centre (FFWC), BWDB already has a website where flood maps are generated and published since August 2002. However, updating of flood map has not been

carried out regularly during this year because flood maps are still under the process of further developments and flood maps also need field verification.

FFWC also publishes Flood bulletins during the flood season. However, information and warnings provided in the b ulletin are only about water levels along major rivers and no information is provided about expected losses due to flood events.

Requirements for further Improvements

- Regional cooperation among neighboring countries to get access to all types of required data on a continuous basis for the entire catchments.
- Automated data recording and collection system can improve data quality.
- A close monitoring and feed back from the users and updating using the feedback data.
- Rainfall estimation using weather radar in conjunction with satellites for measuring rainfall over catchments.
- DEM with higher resolution to produce quality inundation maps. The map has to be updated with new field data.

Prerequisites for Flash flood forecasting

- Automated data recording and collection system that is capable of providing continuous data with shorter intervals.
- Quantitative rainfall forecasts up to small basin level.